USGS

# WATER RESOURCES RESEARCH GRANT PROPOSAL

**Project ID:** 2006AR125B

**Title:** Metal Mobilization, Especially Arsenic, Related to Ground-water Level Fluctuation in the Alluvial Aquifer

**Project Type:** Research

**Start Date:** 03/01/2006

**End Date:** 02/29/2007

**Congressional District:** Third

**Focus Categories:** Geochemical Processes; Water Quality; Hydrogeochemistry

**Keywords:** Arsenic

**Principal Investigators:** Steele, Kenneth F.; Davis, Ralph K (University of Arkansas)

**Federal Funds:** $17,818

**Non-Federal Matching Funds:** $35,636

**Abstract:** Recent publications have documented that about 18 % of wells completed in shallow (24-30m thickness) Quaternary alluvial deposits (alluvial aquifer) in the Bayou Bartholomew watershed in eastern Arkansas region exceed the EPA drinking water maximum contamination level (MCL) of 10 ppb arsenic (Kresse and Fazio, 2002, 2003). Chronic exposure to low levels of arsenic can affect the skin, liver, kidney, circulatory systems, gastrointestinal tract, nervous system, and heart (NRC, 1999). Intensive ground-water withdrawals in eastern Arkansas since the 1970s have caused ground-water level decline with more than 10 ft in some parts of the Mississippi River Valley region (Bryant et al., 1985; Holland, 2004; Joseph, 1999). Moreover some farmers' interviews reveal that in the growing season, daily ground-water level fluctuation as well as annual fluctuation was significant level due to the intensive ground-water pumping in eastern Arkansas, i.e. in the growing season. Considering the relationship between reduction-oxidation condition in ground water and metal mobilization, and ground-water levels causing oxidation-reduction potential energy (Eh) change, the arsenic problem of eastern Arkansas alluvial aquifer appears be related to the oxidation-reduction conditions of the aquifer. Ground-

water level fluctuations in eastern Arkansas lead to fluctuations in reduction-oxidation conditions, which affect metal mobilization, including arsenic and other heavy metals from the aquifer sediments. This indicates that ground-water fluctuation in eastern Arkansas area can accelerate arsenic mobilization from the sediments, and ground-water flow direction change caused by intensive ground-water withdrawals can transport the released arsenic to surface or other water resources. The objectives of the proposed project are 1) to investigate the influence of ground-water level fluctuation on heavy metal mobilization mechanism from the sediment in an alluvial aquifer by lab-scale column experiment, 2) to determine the ground-water flow pattern and its relationship to hydrochemical evolution of the ground-water chemistry, fate of arsenic and potential amount of heavy metals mobilized from sediments by using physico-chemical model in the alluvial aquifer, then to construct a mobilization index to assist in the prediction of heavy metal concentrations in the alluvial aquifer. Also, three conceptual models of arsenic mobilization and release mechanisms will be evaluated by interpreting chemical analyses of sediment and ground water, results of model simulations, and lab-scale column experiments. Sequential acid extraction will be conducted on the collected sediment from my current 104 b project. Lab-scale column test will be designed with the collected sediments in order to investigate the relation between ground-water level fluctuations causing oxidation-reduction condition variation and heavy metal mobilization mechanism. The experiment will be conducted under various flow rate and water level. Prediction of metals including arsenic and possible scenario for securing water resources can be determined by PHREEQC geochemical modeling and MODFLOW and/or integrated hydrologic physical modeling. The results of the project will be applicable to the remainder of the Mississippi River Valley alluvial aquifer, especially in Louisiana, Mississippi, Tennessee, and Missouri, and further integrated water resource management system research.

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